normal; when it is 69° the yield may tend to be 13 per cent above normal; when it is 70° the yield may tend to be 14 per cent above normal; when it is 71° the yield may tend to be 15 per cent above normal; when it is 72° the yield may tend to be 13 per cent above normal; when it is 73° the yield may tend to be 12 per cent above normal; when it is 74° the yield may tend to be 10 per cent above normal; when it is 75° the yield may tend to be 8 per cent above normal; when it is 76° the yield may tend to be 6 per cent above normal; when it is 77° the yield may tend to be 4 per cent above normal; when it is 78° the yield may tend to be 2 per cent above normal; when it is 79° the yield may tend to be 2 per cent below normal. (This is when the rainfall is constant.) July rainfall and corn yield also apparently tend to have a relationship of somewhat this type, a rain of more than 4½ inches in July ordinarily doing little if any more good than a rainfall of 4 inches. In fact, in some years exceedingly heavy July rains seem to have done harm in northern Iowa. Practically none of the weather factors has a strictly linear relationship to corn yield. In the case of May temperature, for instance, a temperature of less than 54° is apparently very severely damaging in the north central part of the corn belt, much more damaging than a straight line of regression would indicate. In years when the May temperature is 6° or 7° below normal it is probable that the yield is cut 20 per cent or 25 per cent below normal, whereas the method of a straight line of regression would indicate a cut of only about 7 per cent below normal. When the temperature is only 2° below normal, however, it is doubtful if the corn yield is really affected by as much as the 2 per cent which the line of regression would indicate. There is a need of developing special types of curves for expressing the different relationships more accurately than straight lines of regression express it. For practical purposes it is probably just as well first to get a general idea of the importance of the various factors at work by using the theory of multiple correlation, and then by applying common sense derived from observation of the methods of corn culture in various sections work out tables somewhat after the fashion of the tables worked out in predicting the yield of corn in Polk County, Iowa. These tables are rather roughly worked out and are certainly open to objection from the standpoint of refined mathematics, but they illustrate the principles involved.

DISCUSSION.

(1) In the central portions of the corn belt much of the corn is grown on bottom lands, subject to overflow. In years of late spring or early summer floods, this corn has to be replanted, and this delays it so much that it is likely to be frosted before reaching maturity. In consequence, the yield for the State is reduced. This disturbing factor, only indirectly connected with the weather of the particular State, could be eliminated by using figures of the yield per acre of corn harvested for grain.

(2) Owing to the differences in the dates of planting corn one year and another, the weather of a particular month does not affect corn in the same way year after year, even if the weather of that month should be identical in, say, two years under consideration. This difficulty could be eliminated by taking the weather not by calendar months but by periods following the mean date when corn was planted in the region each year.

(3) The use of periods as long as a month is unsatisfactory in that a certain month with a mean temperature about normal may appear to have had usual temperatures when in reality it was one with a very hot period and a very cool period, a combination not at all unlikely to occur. The week would seem to be the better unit to use.

(4) Considering (2) and (3) above in conjunction, Prof. Smith's studies of the effect of weather for the 10 days following the average date of tasseling, for example, if applied individually to each year instead of by use of averages, would probably give consistent results.

(5) In the northern part of the corn belt much of the corn is planted without any real hope of harvesting it for grain. In a good year, that is, in a year with weather that would be normal 100 or 200 miles farther south, the corn is harvested with as good a yield as is usually obtained a little farther south. In a poor year, when the weather delays the crop, or when a frost comes unusually early, the corn is harvested for silage. It is evident that the weather of May, June, July, and August may actually be ideal for corn, but yet an early frost may reduce the yield 20 per cent or lower over a large portion of the northern part of the corn belt. This would be like throwing a monkey-wrench into the wheels of the formula.

Thus, the length of the growing season each year and the speed of the development of the crop are important factors to be considered in computing the yield for the northern part of the corn belt.

To make a study in accordance with these suggestions would probably require an impossible amount of labor for one person. But if one investigator takes one aspect or one locality and others do likewise, there may be some hope of a mathematical solution of the effect of weather on crop yields along much more detailed lines than hitherto.—*Charles F. Brooks.*

DAMAGE TO CROPS BY WEATHER.

The Bureau of Crop Estimates publishes a table in the *Monthly Crop Reporter* each year showing the per cent of damage to crops in the United States due to different causes. The figures are from estimates by their large corps of crop correspondents, and "may be regarded as index numbers reflecting the relative influence yearly of different factors affecting yields."

The table below gives the average damage, by the different factors, for the period from 1909 to 1919, inclusive, except for apples and berries, which is from 1912 to 1919:

	Deficient moisture.	Excessive moisture.	Floods.	Frost or freeze.	Hail.	Hot winds.	Storms.	Total weather.	Plant disease.	Insect pests.	Animal pests.	Defective seed.	Total.
Wheat	12.4	2.0	0.3	4.5	1.1	2.0	0.3	22.9	2.7	2.1	0.2	0.2	28.8
Corn	16.3	4.0	.9	2.9	.4	2.2	.5	27.7	.2	2.7	.2	.7	32.1
Oats	13.4	2.7	.3	.8	.8	1.9	.4	20.8	1.7	.9	.1	.2	24.5
Barley	17.1	1.8	.1	.8	1.3	3.2	.4	24.9	1.7	.7	.3	.1	28.7
Flax	21.1	1.3	.1	4.0	1.7	3.0	.2	31.8	2.2	.9	.1	.3	36.4
Rice	6.7	3.1	1.5	.3	(1)	.4	1.8	14.1	1.2	.8	.3	.1	19.0
Potatoes	14.4	3.1	.2	1.6	.1	.7	.1	20.7	4.4	3.2	.1	.3	30.0
Tobacco	8.7	3.7	.6	1.1	.8	.2	.3	15.8	.4	2.6	.....	.1	20.5
Hay	13.4	1.7	.3	1.7	.1	.6	.2	18.4	.1	.5	.1	.1	20.4
Apples	5.4	1.6	.2	14.6	.8	.5	.9	24.9	3.7	3.6	.1	.....	39.6
Berries	9.3	1.7	.2	7.3	.5	.6	.2	20.3	1.1	.6	.1	.....	24.9
Cotton	12.3	4.3	1.0	1.4	.5	1.6	.7	22.3	2.0	9.7	(1)	.2	35.5

[1] Less than 0.05 per cent.

It will be noted that a very large part of the total damage or loss is due to unfavorable weather; also that deficient moisture is the greatest single damaging factor in connection with every crop, except apples. Low temperature causes nearly three times as much damage to apples as dry weather.—*J. Warren Smith.*